

# Design and Implementation of Multi Select Smart Vending Machine

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**Abstract—** Due to the modern life style the usage of vending machine is increased rapidly. Most of the vending machines are based on CMOS, SED, and Microcontroller technology. In this paper VHDL implementation of the FPGA based vending machine is proposed on Mealy Model of Finite State Machine. The whole design is functionally verified using Xilinx ISE simulator 12.1.

**Keywords-**FSM;Vending Machine;VHDL;Xilinx ISE simulator  
FPGA : spartan3 development board.

## I. INTRODUCTION

A vending machine is machine which dispenses small different product, when customer inserts currency or credit into the machine. The commercial coin operated machine was first introduced in London used for selling post cards. Vending machines are more able to be easily used and practical than the standard purchasing method. Most of the vending machines are based on CMOS circuit, SED, and Microcontroller technology [1], [2]. The CMOS and SED based machines are more time consuming than the FPGA based machines.

This paper describes the designing of multi select machine using finite state machine model with advantages of auto billing and cancel features. The FPGA based vending machine is programmable and reconfigurable. Use of such machine saves time and cost. In microcontroller based machine, if the designer wants to enhance the design, the whole architecture must change again. But in FPGA user can easily increase the number of products. The proposed vending machines have the advantages of automatic billing and cancel features.

The conceptual model for the proposed vending machine has been implemented using Spartan 3 development board. In section 2 finite state machine and existed types of Mealy and Moore are explained. The basic operation and necessary steps for the smart Vending Machine is elaborated in section 3. The implementation details covered in section 4. The required explanation of flowchart and its algorithmic procedure of design methodology has mentioned in section 5. All the evaluation results of the proposed design with the required information of screenshots are in section 6. And finally the Conclusion is covered in final section.

## II. FINITE STATE MACHINE (FSM)

Designing a synchronous finite state machine (FSM) is common task for a digital engineer. Finite state machines, also called finite-state automata (singular: automaton) or just finite automata. The current state of the machine is stored in the state memory, a set of n flip flop clocked by a single clock signal. A finite state machine can divided in two types: Moore and Mealy state machines.

Mealy machine is that state machine, which uses only input actions, so that the output depends on the present state and also on inputs. The MEALY machine model is shown in Fig 1.

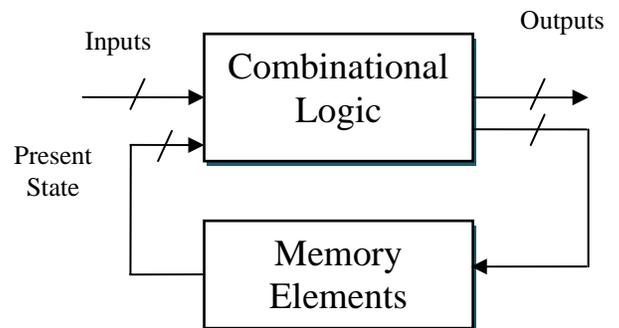


Fig 1: MEALY machine model

Moore Machine is that state machine which uses only entry actions, so that its output depends on the present state. The MOORE machine model is shown in Fig 2.

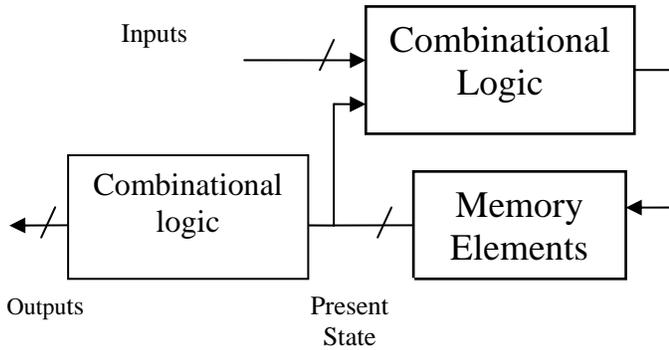


Fig 2: MOORE machine model

In this paper Mealy machine based model is proposed for realization.

### III. OPERATION

The basic operation of any vending machine has resembles the following steps.

- A. Selection: User makes a selection of product.
- B. Waiting for Money Insertion: When user inserts money, money counter tells the control unit, the amount of money inserted in the Vending Machine.
- C. Product Delivery: If correct amount is inserted the product will be dispensed and in case of excess money inserted, the balance amount will be returned to the user.
- D. Service: If the product is not available the vending machine will demand service.
- E. Cancel: when the user wants to withdraw his request and also money will return back.

### IV. IMPLEMENTATION DETAILS

In this paper a state diagram is constructed for the proposed machine can vend four products that are 300ml milk pouch, 1litter mineral water bottle, 500ml Frooti bottle, 500ml sprite bottle. Sel\_1 is used for the selection of milk. Similarly sel\_2, sel\_3, sel\_4 are used for mineral water, frooti and sprite respectively. Rs\_10 and Rs\_5 inputs represent 10 rupee and 5 rupee coins respectively. A cancel input is also used when the user wants to withdraw his request and also money will return through the return1 output. Return1, product and change are output. Money\_count is an internal signal which can be updated at every transition. If the inserted money is more than the total money of products then the change will returned through the change output. The products with their price are shown in table 1.

There are also two input signal clk and reset. The machine will work on the positive edge of clock and will return to its initial state when reset button pressed. The proposed machine is designed using FSM modelling and is coded in VHDL language. The advantages of VHDL implementation includes minimum cost and time, better design, faster time to market

and increased flexibility. The details of entire direction and description are shown in table2.

T able 1. Product with Price

Sl no	Products	Price
1	Milk	10
2	Mineral water	20
3	Frooti	25
4	Sprite	25

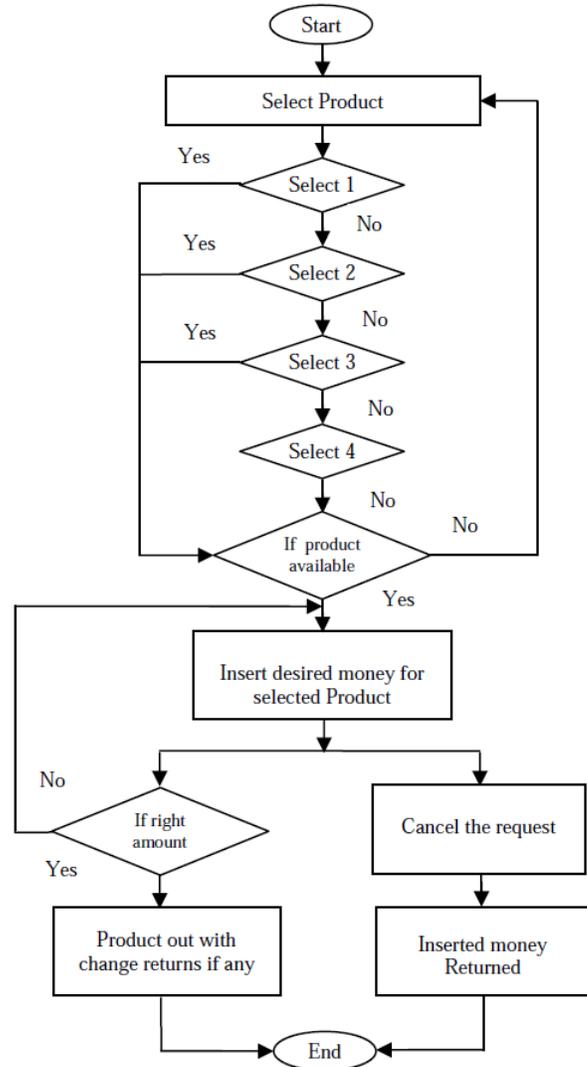


Fig 3: Flow chart for Proposed Vending Machine

Table 2: Ports Description

NAME	DIRECTION	Description
Clk	Input	Clock
Reset	Input	Sync. reset
Sel_1	Input	Milk
Sel_2	Input	Mineral water
Sel_3	Input	Frooti
Sel_4	Input	Sprite
Cancel	Input	Cancel
Rs_10	Input	10 Rupees
Rs_5	Input	5 Rupees
Product	Output	Product out
Change	Output	Extra change
Return1	Output	Return money

V. ALGORITHM DESCRIPTION

The machine has an external reset button, which will bring the machine to the initial state and it becomes ready for the user to select the desired product. For every transition there is a condition so that machine can decide which next state is to be executed. When the user will insert a coin, the machine will check the condition at every transition. After executing the correct condition, the machine will come back to the WAITING state. At the end, the user will get his/her desired product if the inserted amount of money is equal to the price of the selected product. For four products and two coins, there are twenty two states. The complete state diagram is shown in Fig 4.

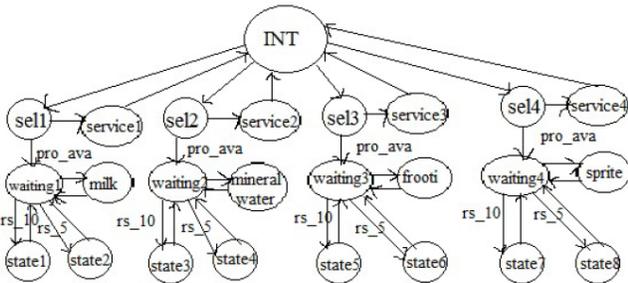


Fig 4. Finite State Machine Diagram of vending Machine

VI. SIMULATION RESULTS

The user wants to purchase milk pouch, then he/she has to push the sel1 button. If the product is available the machine will enter into the waiting\_1 state from the initial state. Now the machine will wait for the coins. The user insert a 10/- rupee coin, the machine will enter into state2, money\_count signal is updated to 10/- and the product is delivered. Fig 5 shows the output.



Fig 5: Simulation waveform showing selection of milk pouch

When the user push the sel3 button, if the product is unavailable then the machine enter to service3 state. From the service3 state the machine moved to initial state. After that the customer can either waits there for the availability of the requested product or customer can choose any other available product. This is shown in Fig 7.

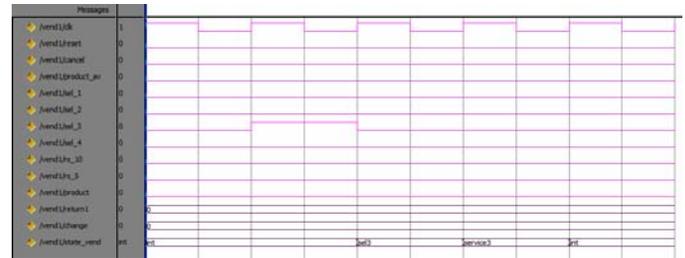


Fig 7: Simulation waveform when frooti\_count=0

If the user wants to purchases the mineral water bottle, then press sel2 button. If the product is available, the machine will enter into waiting 2 state. Then the user insert one 5/-rupee coin and two 10/- rupee coins, money\_count signal is updated to 25/- and the product is delivered. Also give back 5/-rupee coin as change. Fig 8 shows the details.

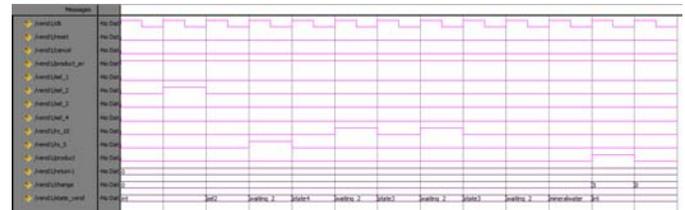


Fig 8: simulation waveform showing selection of mineral water

If the user select product4 and inserts the money and then he further cancels the order, the money inserted is returned back to the customer and the product is not delivered. The output return1 shows the amount of money return back and the Fig 9 shows the prescribed operation.

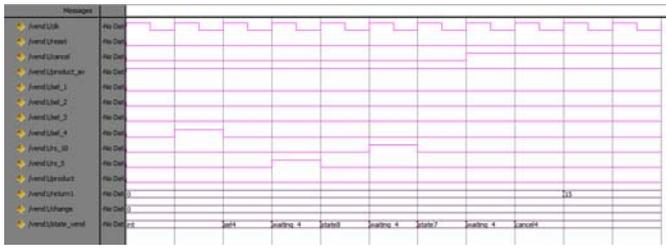


Fig 9: Simulation waveform showing cancel operation

The details of resource utilization are given in table 3. The proposed model has exhibited the delay of 7.890 ns and the calculated maximum operating frequency is 126.744 MHz. The Register Transfer Level (RTL) schematic diagram is shown in Fig 10.

Table 3: Device Utilization Summary

Logic Utilization	Used	Available	Utilization
Number of Slices	133	768	17%
Number of Slice Flip Flops	123	1536	8%
Number of 4 input LUTs	244	1536	15%
Number of bounded IOBs	73	124	58%
Number of GCLKs	1	8	12%

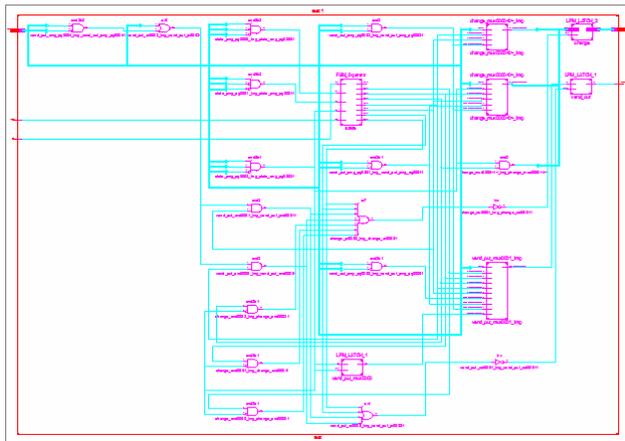


Fig 10: RTL Schematics

## VII. CONCLUSION

The design and implementation of multilevel smart vending machine is functionally verified using Xilinx ISE simulator 12.1 and is implemented in Spartan 3 FPGA board. The result indicate that FPGA based vending machine increases efficiency and accuracy. Its algorithm is very flexible and reliable as the vendor can easily enhance the algorithm for large number of products and coins.

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## AUTHORS PROFILE

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